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# The C-Shaped Root Canal

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## Abstract

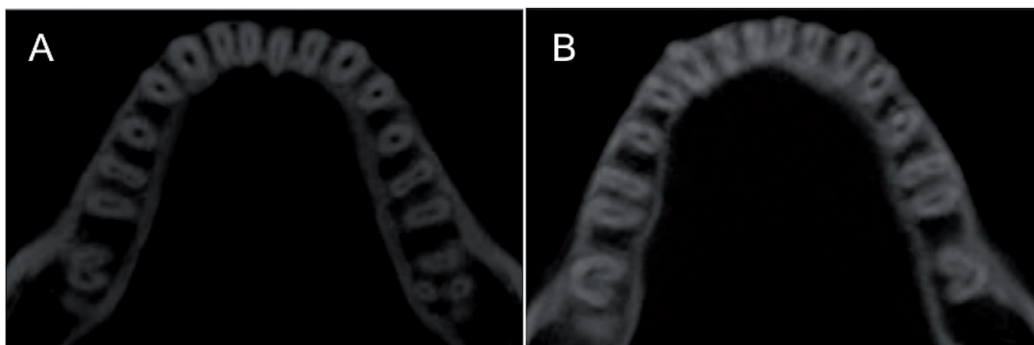
A thorough understanding of root canal anatomy is of paramount importance in the field of dentistry. The C-shaped root canal is an anatomical variation occurring mostly in mandibular second molars. In a transverse section, the shape of this canal is observed as the letter C. The presence of a fin or web connecting the individual root canals is another anatomic feature. Due to its complex anatomy, different classifications have been proposed through the years for a better comprehension. In endodontic literature, the C-shaped root canal has been of high interest and its prevalence is reported in different regions of the world. Additionally, its endodontic management has been widely described and analyzed.

**Keywords:** C-shaped root canal, anatomy, anatomical variation, canal configuration, human teeth

## 1. Introduction

The C-shaped root canal is considered an anatomical variation in human teeth [1] and was firstly documented in endodontic literature by Cooke and Cox in 1979 [2]. This anatomical variation has been widely studied. Additionally, several case reports have described its endodontic management [3–5].

The main cause of a C-shaped root is due to the failure of the Hertwig's epithelial root seath to fuse on the lingual or buccal root surface [1]. The roots of human molars with C-shaped canals may be conical and fused. For these characteristics, studies suggested that C-shaped root canals could be identified based on preoperative radiographs [6, 7]. However, not all conical roots have a C-shaped canal and various reports stated that a C-shaped root canal is not easily seen using only radiographs [6]. On the other hand, additional reports have demonstrated that a



**Figure 1.**

(A) Unilateral C-shaped root canal in mandibular second molar; (B) bilateral C-shaped root canal in mandibular second molar.

C-shaped canal may be bilateral [8] (i.e., when it is present on one side, it can also be present in the contralateral tooth) (**Figure 1**).

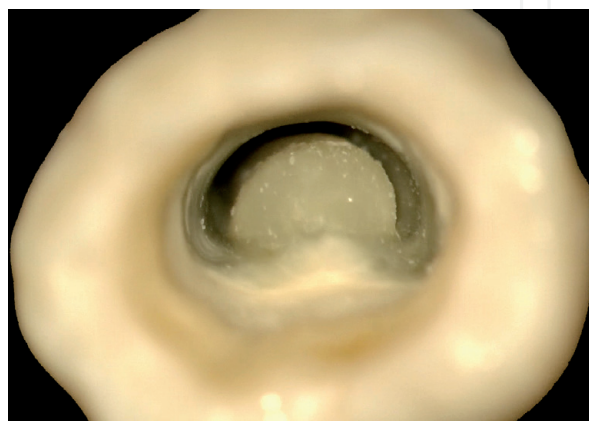
The C-shaped root canal has been found in mandibular and maxillary molars [9, 10], mandibular premolars [11], and even in some incisors [12]. However, it is most commonly present in mandibular second molars [3]. As other anatomical variations, its prevalence has been associated with ethnicity. Interestingly, the prevalence of this canal in Asian populations has been higher than other populations [13].

## 2. Classification

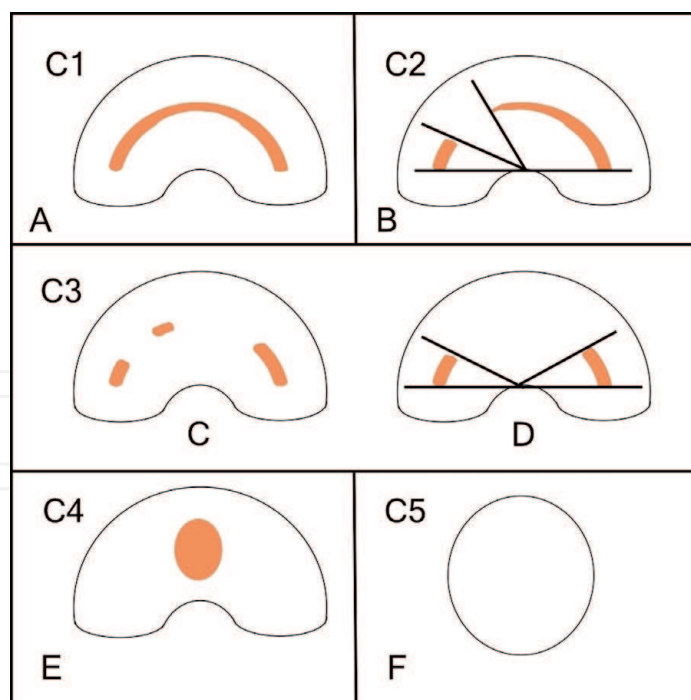
Different techniques have been used to analyze the morphology of C-shaped root canals [14, 15]. In a transverse section of a tooth with this morphology, the shape of the canal is observed as the letter C (**Figure 2**) and different patterns may be present along the canal. The presence of fins connecting the individual root canals is other anatomical feature [1]. Likewise, the shape of the letter C may be interrupted and observed as separate canals [16]; for this reason, different anatomical classifications have been proposed through the years for a better understanding [17, 18].

Although there are different classifications, the following [18] has been commonly cited and well accepted by clinicians (**Figure 3**):

- Category I (C1): the shape was an uninterrupted “C” with no separation or division.
- Category II (C2): the canal shape resembled a semicolumn resulting from a discontinuation of the “C” outline, but either angle alpha or beta was no less than 60°.
- Category III (C3): two or three separated canals and both angles, alpha and beta, were less than 60°.
- Category IV (C4): only one round or oval in that cross-section.
- Category V (C5): no canal lumen could be observed (which was usually seen near the apex only).



**Figure 2.**  
*C-shaped root canal, the shape of the canal is observed as the letter “C.”*



**Figure 3.**  
 This representative illustration explains the classification of C-shaped root canal. (A) Category I; (B) category II; (C) and (D) category III; (E) category IV and (F) category V.

### 3. Endodontic management

In the field of dentistry, the C-shaped root canal has been of high interest, especially in endodontics. Lack of knowledge regarding root canal anatomy may lead to deficient endodontic treatments [19]. Irregular areas in a C-shaped canal can keep remnants of soft tissue, debris, and infected tissue or may be a source of bleeding during a root canal treatment [20, 21]. Therefore, root canal treatments in these cases may require specific skills.

In 1979, the first case reports of C-shaped root canals were documented [2]. Clinical images were presented where the C shape was evident in mandibular and maxillary molars. Since then, numerous case reports have described their clinical management [22].

The chemomechanical preparation and obturation of C-shaped canals have been challenging in some cases [23]. Sodium hypochlorite has been the most used endodontic irrigant because of its antimicrobial properties and tissue-dissolving capabilities [24]. Obturation techniques with warm condensation have been indicated in some cases of C-shaped root canals [25]. Likewise, the use of manual, rotary, and reciprocating files has resulted effective in mechanical preparation of teeth with aberrant anatomies [26].

The disinfection process is affected for isthmuses and other irregularities. Careful exploration with a small, precurved file may be helpful to locate additional canals. Although it is not possible to carry out an appropriate negotiation in all the canals, the penetration of sodium hypochlorite with ultrasonics may allow an effective disinfection process [27].

### 4. Conclusions

A thorough understanding of root canal anatomy is of paramount importance in the field of dentistry. Variations in the number of roots and root canal system

anatomy are not uncommon in human teeth. The C-shaped root canal represents an important and challenging anatomical variation. Likewise, knowledge of the different morphologies of C-shaped root canals can help avoid complications during endodontic treatments.

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